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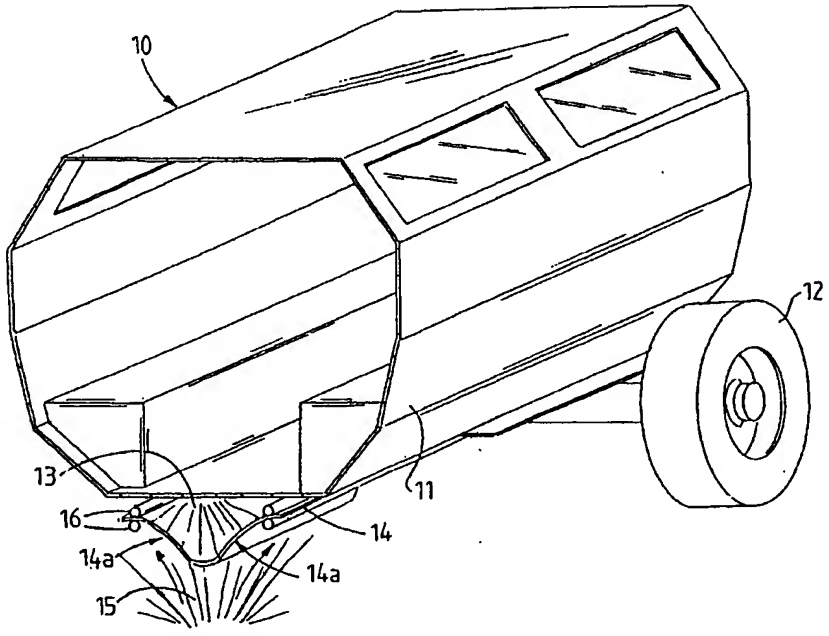
(54) Title: REACTIVE MINE PROTECTION



(57) Abstract: The invention provides a reactive armour arrangement suitable for mine resistance for a vehicle comprising a reactive explosive charge which is adapted to detonate upon detection of a primary explosive detonation such as a landmine detonation, and shielding means which is released or formed upon detonation of the reactive explosive charge to reduce reflection of the primary explosive detonation.

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REACTIVE MINE PROTECTION

FIELD OF THE INVENTION

THIS invention relates to a landmine resistant vehicle, particularly, but not exclusively to an armoured vehicle, tank or the like, and to a reactive armour arrangement for such vehicle.

BACKGROUND TO THE INVENTION

Conventional ordnance such as mine resistant armoured vehicles are provided with a lower hull portion which is V-shaped in cross-section, such V-shaped hull being adapted to deflect the explosive forces of a landmine or the like in transverse directions or to reduce reflection of such forces. A disadvantage of such an arrangement is that the hull of the vehicle has to be raised relative to ground level in order to provide adequate ground clearance. Such a raised hull for example has the disadvantages of a high centre of gravity and a decrease in stability, as well as additional exposure to enemy fire. Such vehicles are therefore also not suitable for track driven craft such as tanks.

OBJECT OF THE INVENTION

It is accordingly an object of the present invention to provide a novel reactive armour arrangement suitable for a vehicle which it is believed will alleviate the above mentioned disadvantages.

SUMMARY OF THE INVENTION

According to the invention, a reactive armour arrangement suitable for mine resistance for a vehicle comprises a reactive explosive charge which is adapted to detonate upon detection of a primary explosive detonation such as a landmine detonation, or the like, and shielding means which is released or formed upon detonation of the reactive explosive charge to reduce reflection of the primary explosive detonation.

In one example the shielding means may comprise a deflector means which is adapted to be transformed to an angled deflection surface upon detonation of the reactive explosive charge.

In an alternative arrangement, the shielding means could be a material which is discharged upon detonation of the reactive explosive charge. Such material could for

example be a particulate material such as sand, or a liquid for example in the form of gel.

In one embodiment in accordance with the invention, the deflector means will be in the form of a deflector plate member, the arrangement being one wherein the reactive explosive charge is disposed between the hull of the vehicle and the deflector plate member.

Thus in one arrangement in accordance with the invention, the deflector plate member will be slidably mounted along at least one longitudinal side thereof to enable it to deform downwardly upon detonation of the reactive explosive charge. Preferably the plate member will deform downwardly in a generally V-shape or U-shaped formation, in order to deflect the primary explosive forces in opposed transverse directions or limit reflection of the primary detonation. With the latter arrangement, the deflector plate member will be slidingly mounted on both longitudinal sides thereof, for example between spaced rows of rollers or the like.

Also according to the invention, the reactive explosive charge could be in the form of an elongate longitudinal charge disposed generally along the longitudinal axis of the vehicle. Preferably such charge will comprise a plurality of longitudinal segments, the arrangement being one wherein only affected segments will detonate upon detection of a primary explosive.

Also included within the scope of the invention is a vehicle provided with the reactive armour arrangement of the invention. Such vehicle could be in the form of an armoured vehicle, tank, or the like.

The invention further includes a method of protecting a vehicle against a primary explosive detonation such as a landmine detonation comprising the steps of providing a reactive explosive charge which is adapted to detonate upon detection of the primary explosive detonation, and causing the reactive explosive charge to release or form a shielding means between the vehicle and the primary explosive charge to reduce reflection of such primary explosive detonation.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features of the invention will appear from the embodiment thereof which is described below as an example without limitation to the scope of the invention, with reference to the accompanying drawings wherein :

Figure 1 is a schematic broken away perspective view of an armoured vehicle in Figure 1 reacting in accordance with the invention;

Figure 2 is a schematic broken away perspective view of an armoured vehicle in Figure 1 reacting to a landmine detonation;

Figure 3 is a schematic side elevation of the vehicle in Figure 1;

Figure 4 is a computer simulation of the effect of a landmine detonation on a vehicle without the reactive armour of the invention;

Figure 5 is a computer simulation of the operation of reactive armour of the invention in reaction to a landmine detonation; and

Figure 6 is a graphic representation of momentum/time of a computer simulation of the operation of reactive armour of the vehicle in Figure 1.

Figure 7 is a schematic broken away perspective view of a different embodiment of an armoured vehicle in Figure 1 reacting to a landmine detonation.

Figures 8, 9 10, 11, 12 show an experimental verification of the simulation shown in Figures 4, 5 and 6.

Figure 8 describes the experimental set out and the results. Figure 8 also illustrates the structural test piece which was protected by means of the method of the invention, and shows an elevation of the test piece, an end elevation, a plan, and a perspective view thereof.

Figure 9 is a graphic representation of the results of the experiment showing at the suppression compared with a base line. The graph indicates the distance the plate travels against time.

Figure 10 is a perspective photograph of the experimental set up.

Figure 11 is a photograph showing the protective plate 52 after detonation of the secondary explosive charge indicating that the plate is transformed in to a generally V-shaped configuration.

Figure 12 is a photograph of an end view of the plate and experimental set up in Figure 11.

Referring to the drawings, in one example, an armoured vehicle 10 in accordance with the invention includes a hull structure 11 mounted on wheels 12 or tracks. It is a feature of the invention that the floor or base 11a of the hull structure 11 presents a generally planar flat surface which lies in a generally horizontal plane, although it may be contoured upwardly in a V or U formation if desirable for any reason. Thus the flat base 11a of the hull 11 enables the vehicle 10 to present a relatively low profile and a low centre of gravity. The advantages of such an arrangement are for example that the vehicle will have increased stability, and present a lower target, relative to a conventional hull with a downwardly extending V-shaped base, not shown.

In order to render the hull 11 resistant to a primary landmine explosions 15, Figure 2, or the like, the invention envisages that a secondary elongate longitudinal reactive explosive charge, shown schematically at 13, will be disposed below the base 11a of the hull 11. It is envisaged that the reactive explosive charge will be provided in a plurality of individual segments which can be detonated as required in order to counter the primary landmine detonation.

The reactive armour of the invention further includes a plate member 14 which is disposed below the reactive explosive charge 13, so that the charge 13 is disposed between the plate member 14 and the floor 11a of the hull 11. It has been found that such plate member 14 will be deflected downwardly, Figure 2, by means of the reactive explosive charge 13 when activated by a primary blast 15, and thus constitute one or more deflecting surfaces 14a for purposes of reducing the destructive character of the primary blast 15. In a preferred arrangement the plate member 14 will be deflected downwardly to form a generally V or U-shaped structure in cross-section, Figure 2. In an alternative arrangement, not shown, one longitudinal side of the plate member 14 can be deflected downwardly so as to present a single angled deflector surface to the primary blast 15. The deflecting surfaces 14a will thus have the effect of reducing reflection of the pressure wave of the primary blast 15.

An alternative method of reducing reflection of the pressure blast could be achieved by releasing a particulate material 54 or a liquid from the hull 11, Figure 7, by means of

the reactive explosive charge 13. Such material 54 could for example comprise sand or other particulate material, or liquid in the form of a gel material. This arrangement is shown in Figure 7 of the accompanying drawings wherein the material to be released is carried in a housing 50 mounted below the floor 11a of the hull 11 and is adapted to be sprayed downwardly and outwardly as shown upon detonation of the reactive explosive charge 13. The reactive charge 13 will preferably be housed above the material. The container for the material could be held in an elongate trough-like structure which is generally conical in cross-section, not shown, in order to guide the material downwardly and outwardly. Alternatively the material could be housed in a tubular container 50 which is generally circular in cross-section, not shown, with the reactive explosive charge 13 disposed along the upper zone thereof.

In the arrangement illustrated, the deflector plate member 14 is mounted between spaced longitudinal rollers 16 along each side thereof to permit inward movement of the plate 14 over such rollers 16 upon detonation of reactive explosive charge 13. Clearly variations are possible in this regard and the invention is not limited to the mounting arrangement illustrated.

Figure 4 is a computer simulation of pressure contours below the hull 11 of a vehicle, at 200 micro seconds after a primary blast 15, without the reactive armour arrangement of the invention. It will be noted that the shock wave is reflected symmetrically from the vehicle 10. A peak pressure of 129 MPa is indicated.

In Figure 5 of the drawings, a computer simulation of effect of the reactive armour of the invention is illustrated. The pressure contours below the vehicle hull 11 are again shown at 200 micro seconds. In this instance, the reactive armour arrangement of the invention has been provided, with a reactive explosive charge 13 disposed between the floor 11a of the hull, and the deflector plate 14. It will be noted that the secondary reactive detonation 13 has the effect of deflecting a portion of the primary detonation 15 transversely, so that at a significant portion of the blast is directed past the sides of the hull 11 of the vehicle 10.

A further significant aspect of the invention is that the time period during which the primary landmine detonation 15 impacts on the hull 11 is delayed. The result of such delay is therefore that the energy of the primary blast 15 directed to the hull 11 is delayed, and the impact thereof less intense. This feature of the invention is illustrated in Figure 6 which is a graphic representation of a computer simulation showing the momentum transfer to the hull 10 on the Y-axis, and the time period during which it impacts on the hull on the X axis. The curve 21, illustrates the result of a blast 15 with the reactive armour arrangement of the invention; while the curve 20, is the result of a blast 15 without having the reactive armour of the invention.

With reference to Figure 6 of the drawings, in the baseline case shown in Figure 4, it will be noted that the momentum is rapidly transferred to the hull 11, with approximately 1000 N-s being recorded at 400 micro seconds.

With the reactive armour of the invention, the time period during which momentum is transmitted to the hull 11 of the vehicle 10, is delayed significantly. Thus, the momentum transferred to the hull 10 reaches a value of 1,000 N-s approximately 100 micro seconds after later than the baseline case. The time gain due to the deflector plate 14 is negated after about 480 micro seconds due to the reflection of the reflector plate 14. It is however anticipated that a further improvement can be expected with suitable dampening, not shown.

Figures 8 to 12 show an experimental verification of the computer simulation described above with reference to Figures 4 to 7. Figure 8 describes the experimental set up and the results. Figure 8 also illustrates the structural test piece which was supported above ground level over a sandpit 51, and which is protected by means of the plate member which is indicated at 52, Figures 10, 11, 12, and which is deformed by means of the reactive explosive charge, not shown. The structural test piece is supported above the same pit 51 by means of supports 53, Figure 10, 11, 12.

Figures 12 and 11 illustrate the plate 52 which has been deformed by means of reactive explosive charge 13. It will be noted that the plate is deformed to a generally V-

shaped profile which will have the effect of deflecting the primary explosive force, or to a large extent preventing reflection thereof and thus reducing pressure on the hull of the vehicle 10.

Doubtless variations of the invention exist without departing from the principles set out in the consistory clauses. In alternative arrangements, not shown, a plurality of adjacent plate members 14 could be provided below the hull, below the reactive explosive charges 13 and adapted to be deflected downwardly as required. Likewise, different arrangements of reactive charges 13 could be employed, the object being to deflect the deflector plate or plates 14 downwardly towards the primary detonation 16 upon detection of the latter.

Claims

1. A reactive armour arrangement suitable for mine resistance for a vehicle comprising a reactive explosive charge which is adapted to detonate upon detection of a primary explosive detonation such as a landmine detonation, and shielding means which is released or formed upon detonation of the reactive explosive charge to reduce reflection of the primary explosive detonation.

2. Reactive armour arrangement according to claim 1 wherein the shielding means comprises a deflector means which is adapted to be transformed to an angled deflection surface upon detonation of the reactive explosive charge.

3. The reactive armour arrangement according to claim 1 wherein the shielding means is a material which is discharged upon detonation of the reactive explosive charge.

4. The reactive armour arrangement according to claim 3 wherein the material is a particulate material such as sand which is discharged downwardly upon detonation of the reactive explosive charge.

5. The reactive armour arrangement according to claim 3 wherein the material is a liquid such as a gel which is discharged downwardly upon detonation of the reactive explosive charge.

6. The reactive armour arrangement according to claim 2 wherein the deflector means is a deflector plate member, the arrangement being one wherein the reactive explosive charge is disposed between a hull of the vehicle and the deflector plate member.

7. The reactive armour arrangement according to claim 2 or claim 6 wherein the deflector plate member is slidably mounted along at least one longitudinal side of the vehicle to enable it to deform downwardly upon detonation of the reactive explosive charge.

8. The reactive armour arrangement according to claim 6 or claim 7 wherein the deflector plate member is adapted to deform downwardly in a generally V-shaped formation in order to reduce reflection of the primary explosive detonation.

9. The reactive armour arrangement according to claim 8 wherein the deflector plate member is slidingly mounted on both longitudinal sides thereof.

10. The reactive armour arrangement according to claim 9 wherein the deflector plate is slidingly mounted on both longitudinal sides thereof between spaced rows of rollers.

11. The reactive armour arrangement according to any one of claims 1 to 10 wherein the reactive explosive charge is an elongate charge disposed generally along the longitudinal axis of the vehicle.

12. The reactive armour arrangement according to claim 11 wherein the charge comprises a plurality of longitudinal segments, the arrangement being one wherein only affected segments will detonate upon detection of a primary explosive detonation.

13. A reactive armour arrangement suitable for mine resistance for a vehicle substantially as herein described and exemplified with reference to the accompanying drawings.

14. A method of protecting a vehicle against a primary explosive detonation such as a landmine detonation comprising the steps of providing a reactive explosive charge which is adapted to detonate upon detection of the primary explosive detonation and causing the reactive explosive charge to release or form a

shielding means between the vehicle and the primary explosive charge to reduce reflection of such primary explosive detonation.

15. The method according to claim 14 wherein the shielding means comprises a deflector means, including the step of transforming the deflector means to an angled surface upon detonation of the reactive explosive charge.

16. The method according to claim 14 wherein the deflector means is transformed to a generally V-shaped formation in order to reduce reflection of the primary explosive detonation.

17. The method according to claim 14 wherein the shielding means comprises a particulate or fluid material including the step of discharging such material downwardly upon detonation of the reactive explosive charge.

18. The method according to claim 17 including the step of discharging the material downwardly and laterally outwardly upon detonation of the reactive explosive charge.

19. A method of protecting a vehicle against a primary explosive detonation such as a landmine detonation substantially as herein described and exemplified with reference to the accompanying drawings.

20. A vehicle which includes a reactive armour arrangement as claimed in any one of claims 1 to 13.

21. A vehicle according to claim 16 substantially as herein described and exemplified with reference to the accompanying drawings.

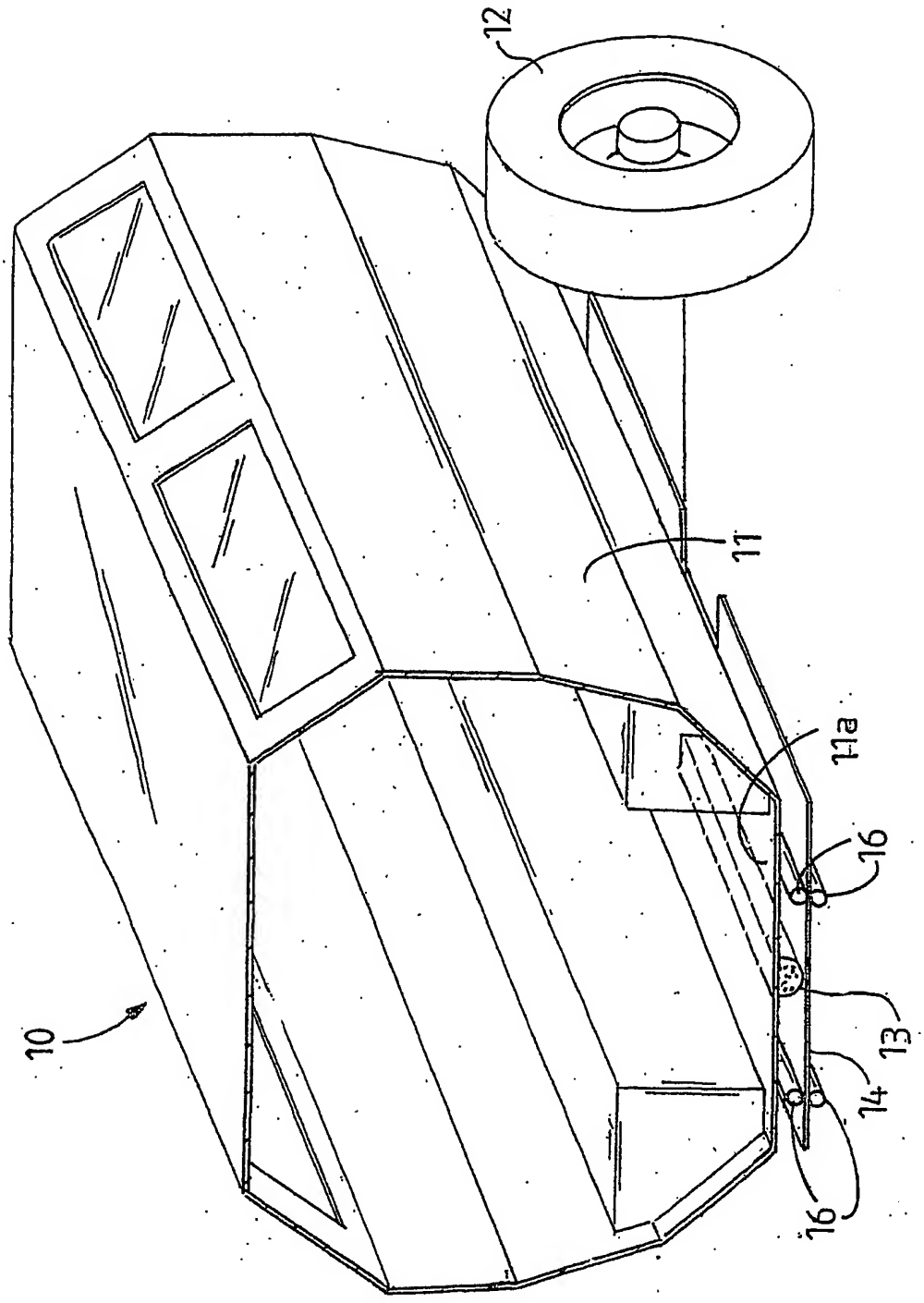


FIGURE 1

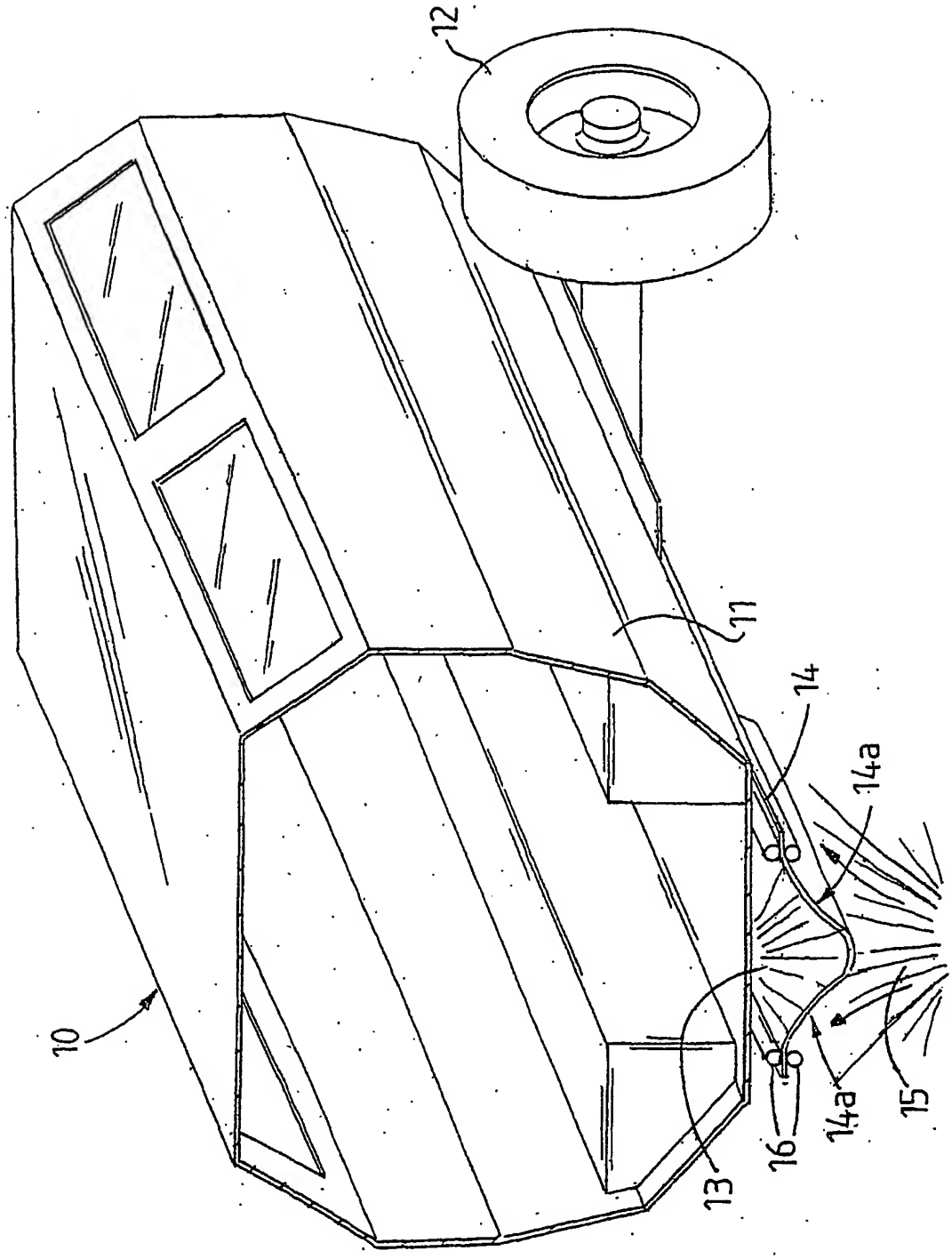


FIGURE 2

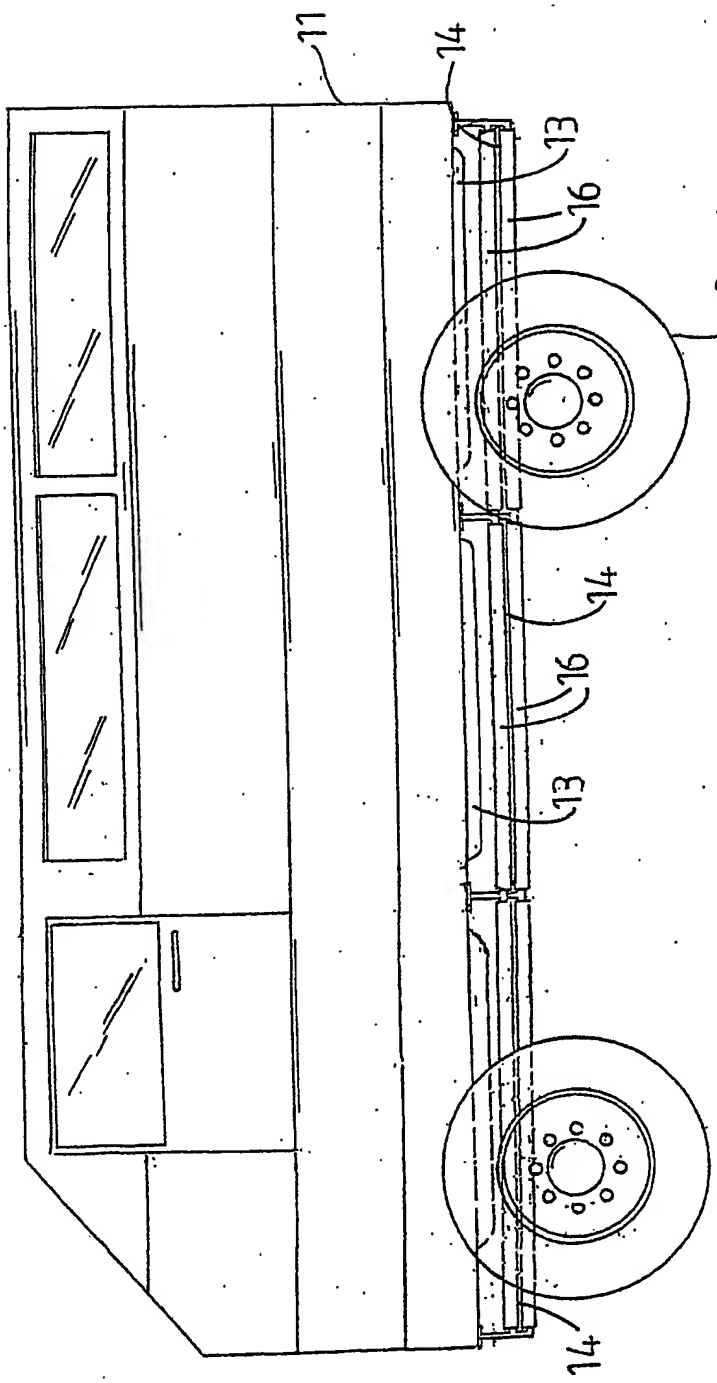


FIGURE 3

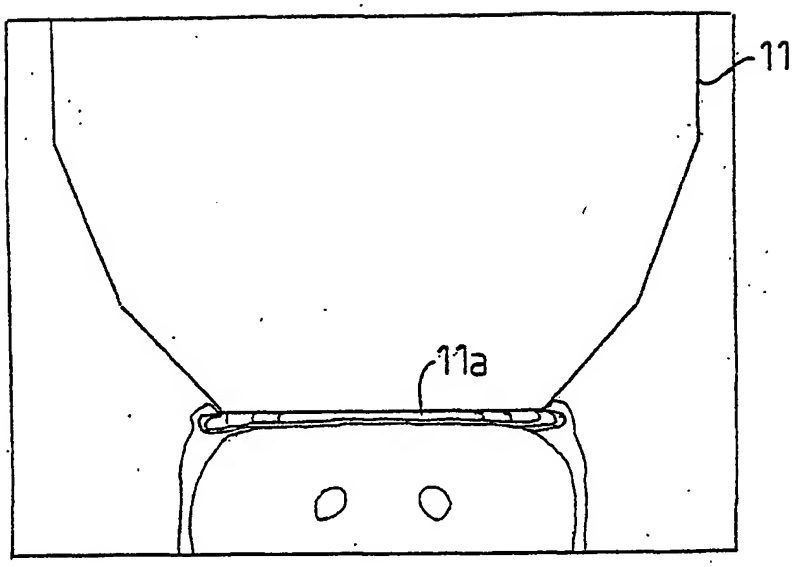


FIGURE 4

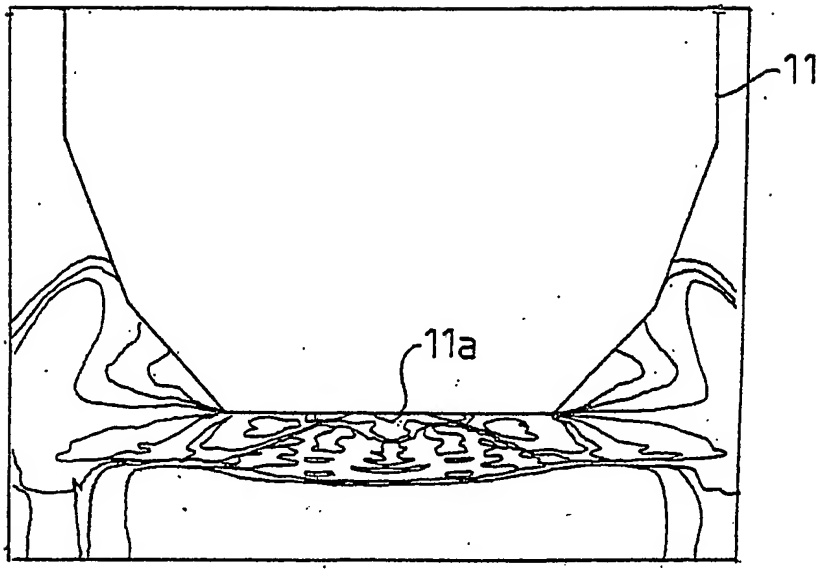


FIGURE 5

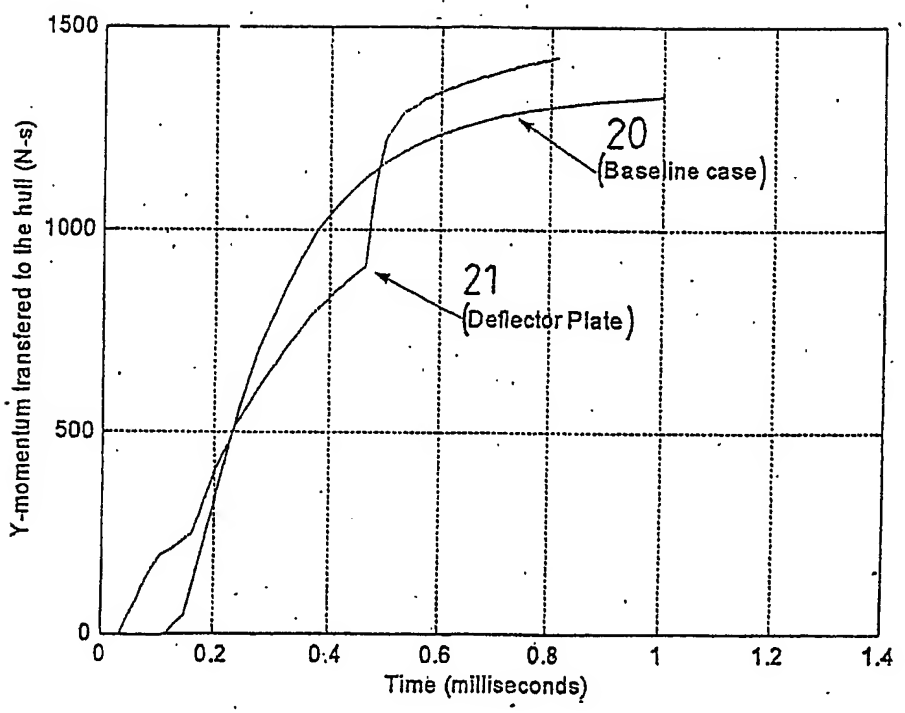

1500
1000
500
0
Y-momentum transfered to the hull (N-s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Time (milliseconds)
20
(Baseline case)
21
(Deflector Plate)

FIGURE 6

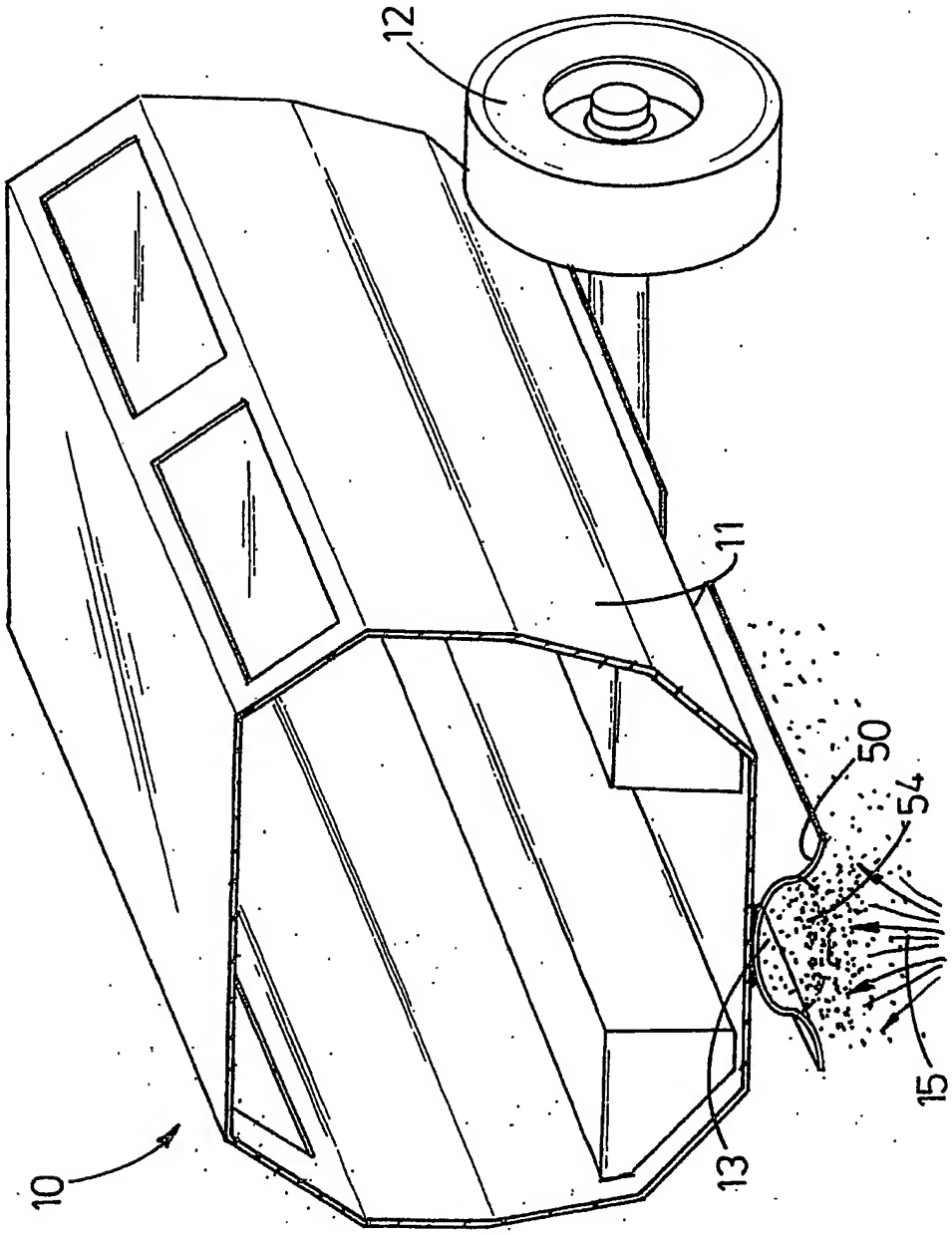


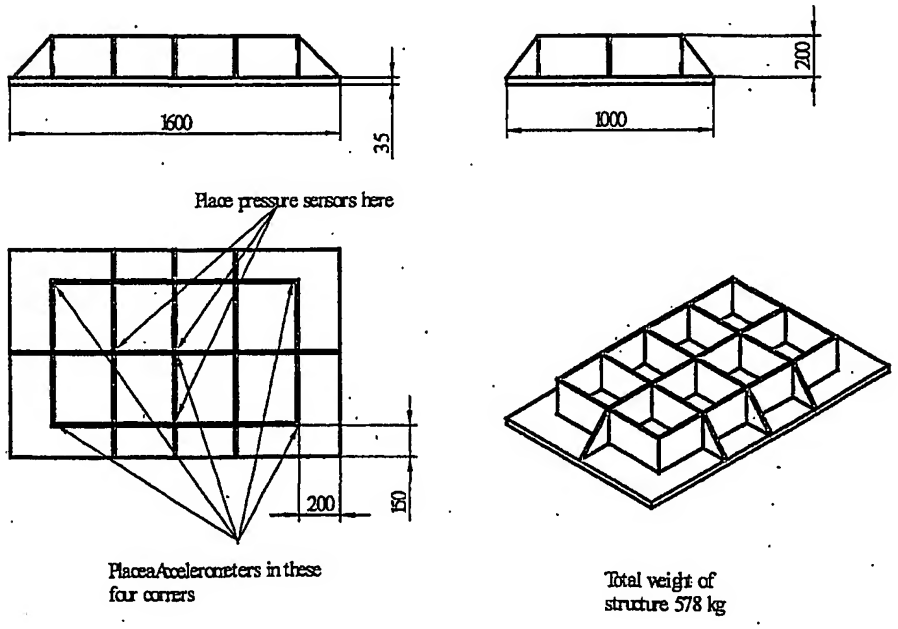
FIGURE 7

Experimental Verification of the Active Land Mine Suppression Concept

Experimental Set-Up

A re-usable test piece was constructed as shown below. The experimental set-up, included the following items:

- A sandpit 51, Figures 11, 12 of 6 meters by 10 meters onto which the experiment and explosive are placed. This is to have repeatable blast conditions. Between blast tests the sand is tilled and re-compacted.
- High-speed pressure and acceleration transducers to measure the shock loads on the structure. These sensors were sampled at a rate of 1 MHz.
- Low-speed accelerometers to measure the total momentum imparted onto the plate 52, Figures 10, 11, 12, by the blast.
- The baseline charge for comparison is an 800 gm Pentolite booster. These items were chosen because repeatability is ensured by strict quality control measures.
- Stilts 53, Figures 10, 11, 12, to suspend the test item a height of 500 mm above ground level.
- A hardened computer used for capturing the data.

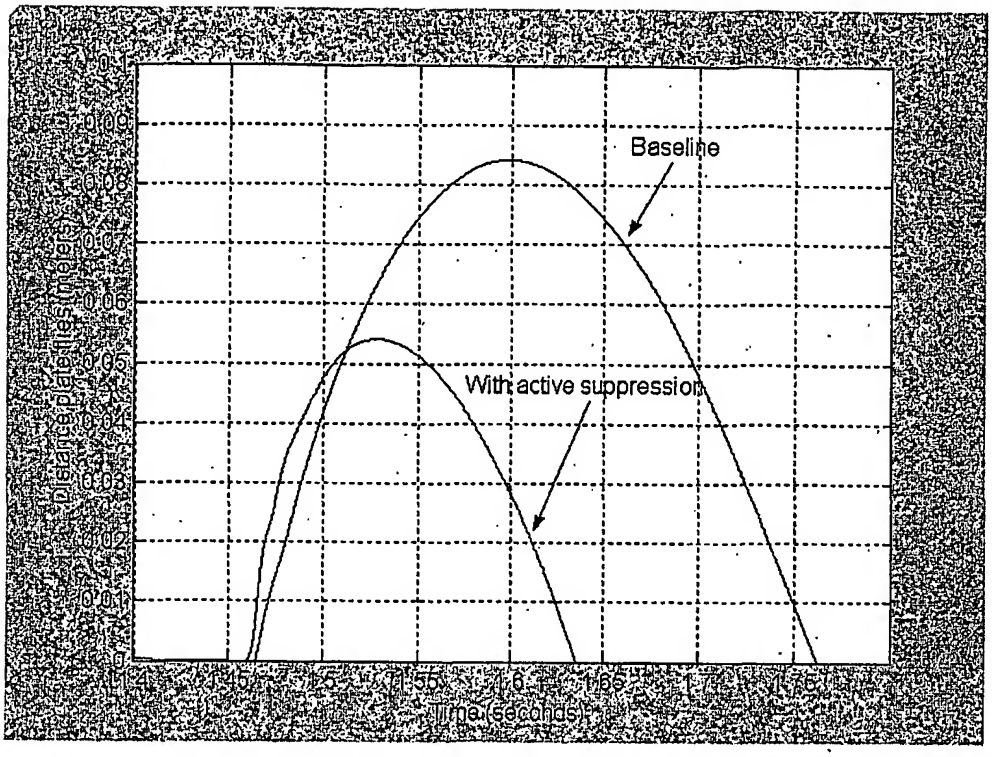


Structural test piece.

Results

The slow speed accelerometers was integrated twice to yield the distance that the plate is displaced upwards. This is shown in the graph in Figure 9 for the baseline case of 800 gm Pentolite underneath the test piece which is 500 mm above the explosive.

FIGURE 8



Distance the test piece is displaced upwards due to the effect of the blast from an 800 gm Pentolite booster.

FIGURE 9

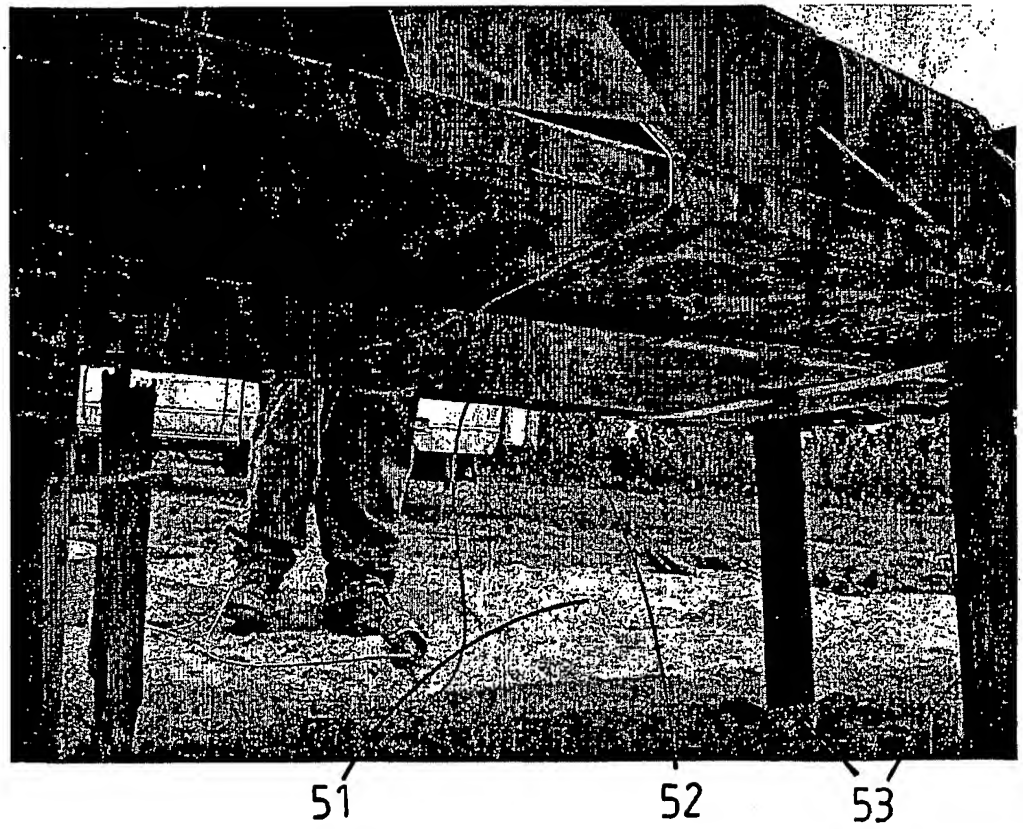


FIGURE 10

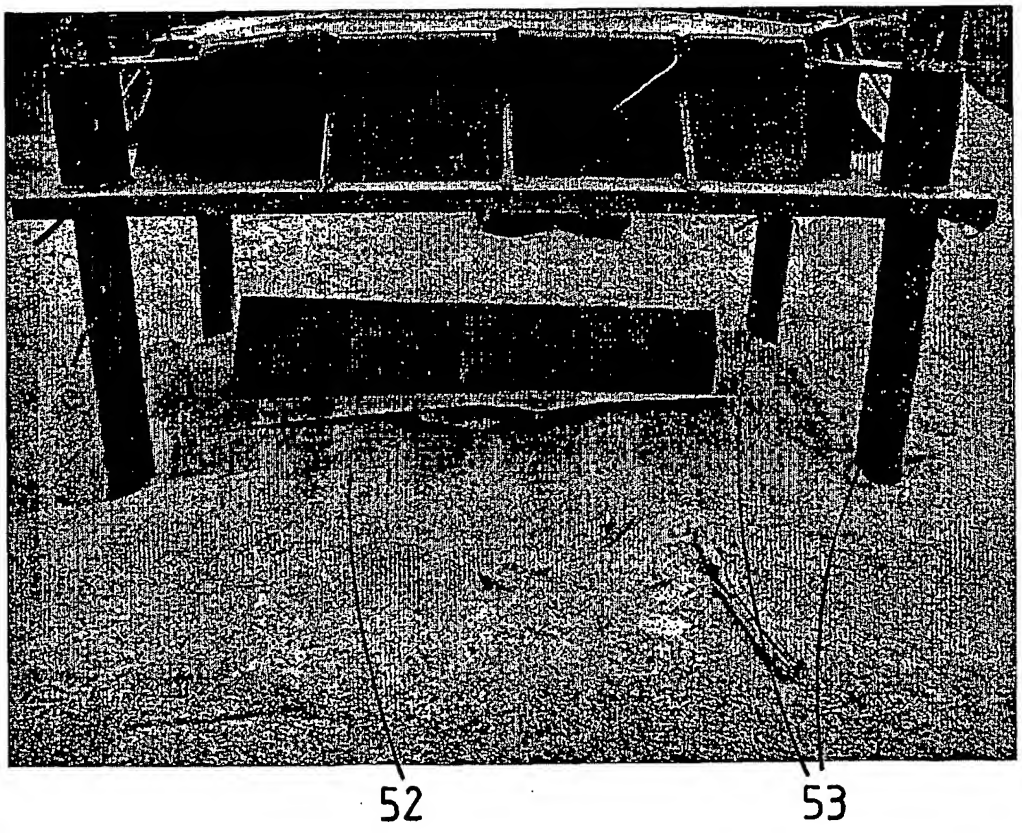


FIGURE 11

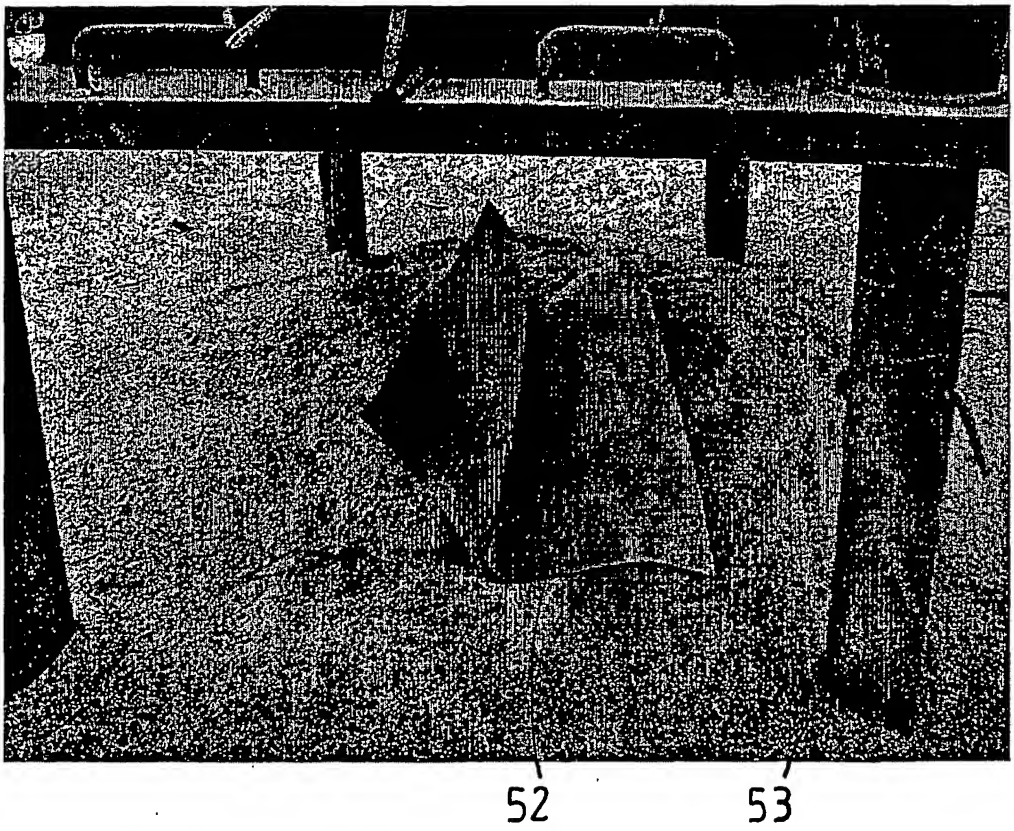


FIGURE 12

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(74) Agent: LE ROUX, Marius; D.M. Kisch Inc., P.O. Box 781218, 2146 Sandton (ZA).

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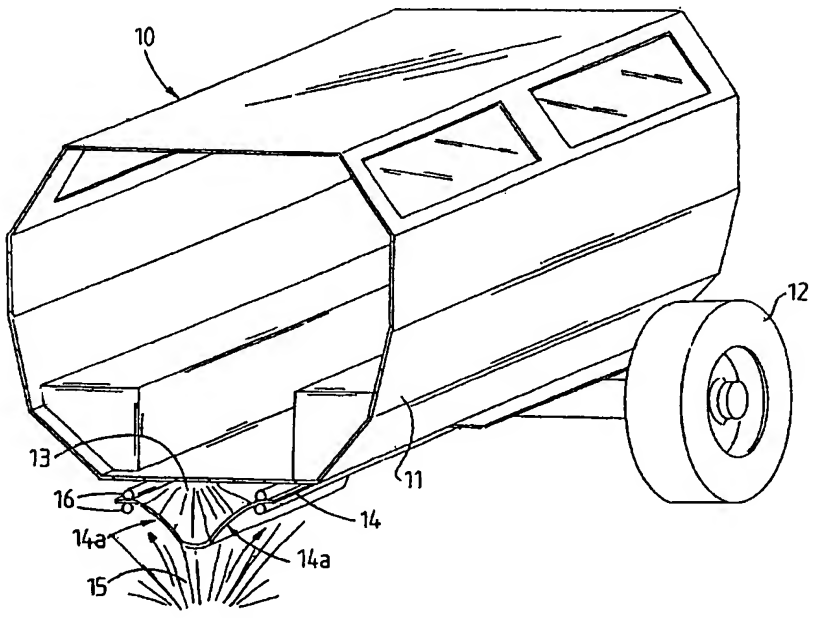

(57) Abstract: The invention provides a reactive armour arrangement suitable for mine resistance for a vehicle comprising a reactive explosive charge (13) which is adapted to detonate upon detection of a primary explosive detonation such as a landmine detonation, and shielding means (14) which is released or formed upon detonation of the reactive explosive charge to reduce reflection of the primary explosive detonation.

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A. CLASSIFICATION OF SUBJECT MATTER
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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 012 721 A (MEDIN GUNNAR ET AL) 7 May 1991 (1991-05-07) column 2, line 58,59 column 3, line 33 -column 4, line 18 figures 1-5	1-7, 11-15, 17-21
Y	---	16
Y	DE 199 13 845 A (HENSCHEL WEHRTECHNIK GMBH) 28 September 2000 (2000-09-28) column 2, line 60-68 figure 4	16
X	---	1-3,6, 11-15, 19-21
	DE 28 22 106 C (DAIMLER BENZ AEROSPACE AG) 22 August 1996 (1996-08-22) column 1, line 35 -column 2, line 37 figure 1	

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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3 May 2002	13/05/2002

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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